Hack In The Box Conference 2011, Amsterdam

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SQL Injection with ABAP

Ascending from Open SQL Injection to ADBC Injection

Who am I

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Andreas Wiegenstein

- CTO and founder of Virtual Forge, responsible for R&D
- SAP Security Researcher, active since 2003
- Speaker at SAP TechEd 2004, 2005, 2006, DSAG 2009, BlackHat 2011
- Co-Author of "Secure ABAP Programming" (SAP Press)

Virtual Forge GmbH

- SAP security product company based in Heidelberg, Germany
- Focus on (ABAP) application security services
  - ABAP Security Scanner
  - ABAP Security Guidelines
  - ABAP Security Trainings
  - SAP Security Consulting

Belief: "Our SAP system is secure."

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- Roles & Authorizations
- Segregation of Duties
- Secure Configuration & System / Service Hardening
- Encryption
- Secure Network Infrastructure
- Password Policies
- Patch Management
- Identity Management
- Single Sign-on

SUPER-GREEN!

Reality-Check

"...and this is our ABAP security department."

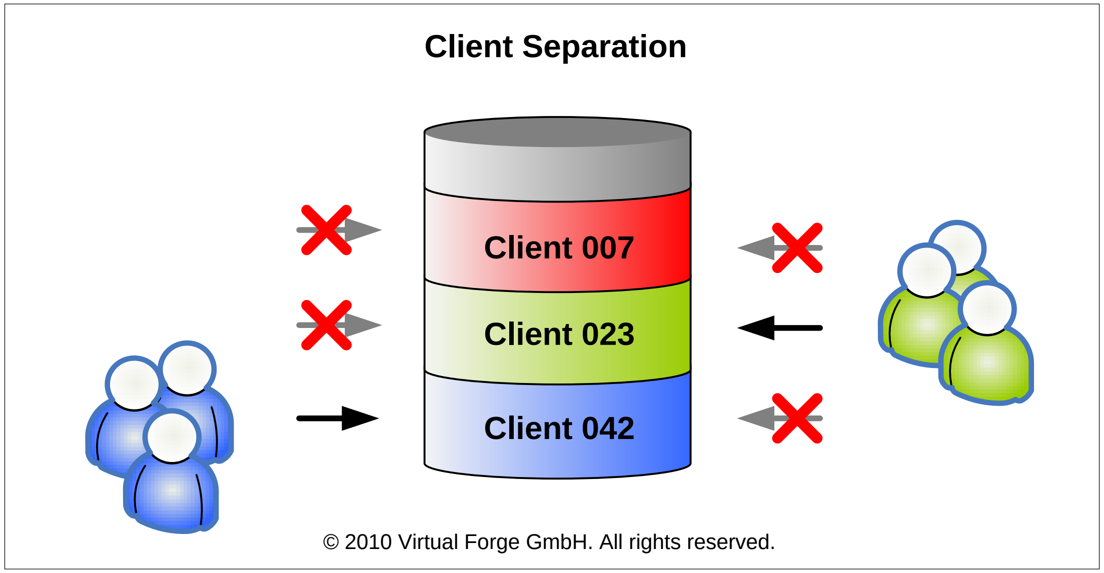
Inhalt

1. …and then there was ABAP

Advanced Business Application Programming

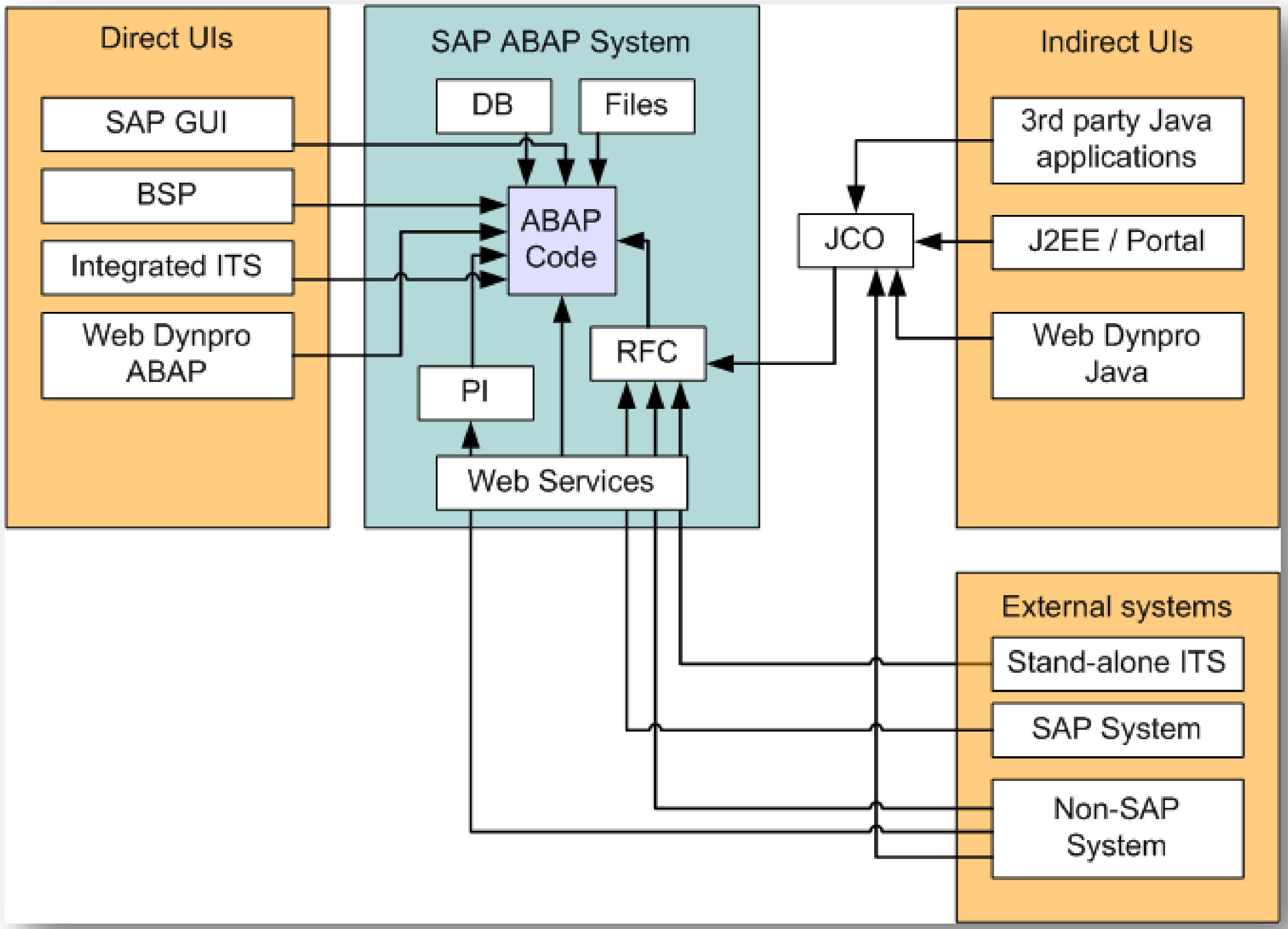
- Proprietary language, exact specification not (freely) available
- Platform-independent code
- Client separation built-in *
- Integrated auditing capabilities
- System-to-System calls via SAP Remote Function Call (RFC)
- Client-Server communication via SAP GUI (DIAG protocol)
- Various programming paradigms:
  - Programs & Forms, Reports, Function Modules, Dynpros
  - Classes & Methods, Business Server Pages, Web Dynpro ABAP
- Integrated platform-independent SQL Standard: Open SQL
- Built-in authentication, roles and (explicit) authorization model
- Thousands of well-known standard programs and database tables
- 150+ Million Lines of Code in an ECC6.0 System

A closer look at Client Separation



- Users log on to "clients"
- Clients represent business (and user) data of independent organizations
- The SAP system implicitly separates client data in the database
  - Done via a special column that indicates, if a table is client-dependent
- ABAP code is client-*independent.* Every program is available on all clients

Attack Surface of ABAP



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2. SQL Injection revisited

SQL Injection Overview

- Special form of In-band Signalling
  1) Data (input) is combined with commands (SQL syntax)
  2) Result (data + commands) is executed
  3) Commands embedded in data can corrupt the intended SQL commands

- Typical test patterns
  - `' or 1=1 --`
  - `' or 1=1 /*`

- Countermeasure: Prepared Statements

- SQL Injections are known at least since 12/1998 (Phrack.org issue #54)

SAP-specific SQL Injection Risks

- Illegal access to data in other clients
- Modification of user accounts and user authorizations (SOX violation)
  - E.g. Assign unauthorized user SAP_ALL privileges
- Undocumented changes to critical database tables (SOX violation)
  - No records in CDHDR, CDPOS, …
- Read access to HR data (Privacy issue)
  - E.g. social security number (PA0002-PERID)
- Access to credit card data (PCI/DSS violation)
  - E.g. BSEGC-CCNUM
- Access to bank accounts of customers and suppliers
  - E.g. customer bank account data (KNBK-BANKN)
- Manipulation of financial data (SOX violation)
  - E.g. tampering with BSEG

3. Open SQL (OSQL) Overview, Risks & Mitigations

Open SQL Overview

- Open SQL commands are integrated in the ABAP language
  - SELECT, UPDATE, INSERT, DELETE, MODIFY
  - OSQL commands are compiled together with the ABAP program
- Most ABAP Code (>95%) uses Open SQL for DB queries
- Open SQL automatically enforces SAP security features
  - Only defined database commands can be executed
  - Client separation
  - Logging

Open SQL Example #1

Simple OSQL query (SELECT)

```
REPORT  SQL_01.

DATA lt_sec TYPE sbook.

PARAMETERS p_carrid TYPE string.

SELECT class passname fldate
  FROM sbook
  CLIENT SPECIFIED
  INTO CORRESPONDING FIELDS OF lt_sec
  WHERE carrid   = p_carrid
    AND reserved = ' '.

  WRITE : / lt_sec-class, lt_sec-passname, lt_sec-fldate.
ENDSELECT.
```

NO SQL INJECTION

Open SQL Example #2

OSQL query with dynamic WHERE condition

```
REPORT  SQL_02.

PARAMETERS p_carrid TYPE string.

DATA lt_sec   TYPE sbook.
DATA lv_where TYPE string.

CONCATENATE `carrid = '` p_carrid `' AND reserved = ' '`
  INTO lv_where.

SELECT class passname fldate
  FROM sbook
  CLIENT SPECIFIED
  INTO CORRESPONDING FIELDS OF lt_sec
  WHERE (lv_where).

  WRITE : / lt_sec-class, lt_sec-passname, lt_sec-fldate.
ENDSELECT.
```

OSQL INJECTION

Open SQL Example #3

OSQL query with dynamic table access

```
REPORT  SQL_03.

PARAMETERS p_table  TYPE string.

DATA lt_sec   TYPE sbook.
DATA lv_table TYPE string.

CONCATENATE `S` p_table
  INTO lv_table.

SELECT *
  FROM (lv_table)
  CLIENT SPECIFIED
  INTO CORRESPONDING FIELDS OF lt_sec.

  WRITE : / lt_sec-class, lt_sec-passname, lt_sec-fldate.
ENDSELECT.
```

GENERIC TABLE QUERY

OSQL Injection Demos

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DEMO

SAP Mitigation(s)

- SAP Note 1520356 - Avoiding SQL Injections (https://service.sap.com/sap/support/notes/1520356)
- ABAP countermeasures available since 12/2010

SAP Mitigation(s) … a closer look

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- ABAP strings are *usually* enclosed in ` (back ticks)

```
DATA str TYPE string.
str = `Hello string`.
```

- ABAP char arrays are *usually* enclosed in ' (single quotation marks)

```
DATA chr TYPE c LENGTH 80.
chr = 'Hello char'.
```

- Hence ` as well as ' can be used in dynamic OSQL to enclose variables

```
CONCATENATE `carrid = '` p_carrid `' AND reserved = ' '` INTO str.
CONCATENATE 'carrid = `' p_carrid '` AND reserved = ` `' INTO chr.
```

- SAP countermeasures include two methods to escape quotes

```
cl_abap_dyn_prg=>escape_quotes_str(str)
` -> ``
cl_abap_dyn_prg=>escape_quotes(chr)
' -> ''
```

SAP Mitigation(s) have Risks

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- The method-names suggest usage for a given variable type

  ```
  cl_abap_dyn_prg=>escape_quotes_str
  ```

  -> to use for strings

  ```
  cl_abap_dyn_prg=>escape_quotes
  ```

  -> to use for non-strings (character arrays)

- Careful: It's not the variable-type that's relevant but the *type of quote* used!
- Risk: The method-names are misleading and may confuse developers

  ```
  DATA lv_where TYPE string.
  P_carrid = cl_abap_dyn_prg=>escape_quotes_str( p_carrid ).
  CONCATENATE `carrid = '` p_carrid `' AND reserved = ' '` INTO lv_where.
  ```

WRONG
ESCAPING

SAP Mitigation(s) … recommendation

- Avoid

```
cl_abap_dyn_prg=>escape_quotes_str
cl_abap_dyn_prg=>escape_quotes
```

- Use

```
cl_abap_dyn_prg=>quote_str
cl_abap_dyn_prg=>quote
```

- These functions not only **escape** the input, but also **wrap** it in the same quote character they escape

```
DATA lv_where TYPE string.
P_carrid = cl_abap_dyn_prg=>quote_str( p_carrid ).
CONCATENATE `carrid = ` p_carrid ` AND reserved = ' '` INTO lv_where.
```

- Examples

```
cl_abap_dyn_prg=>quote_str( )  O`Neill -> `O``Neill`
cl_abap_dyn_prg=>quote( )      O'Neill -> 'O''Neill'
```

SECURE ESCAPING

4. Native SQL

Native SQL Overview

- "Native SQL" is SQL placed inside specific ABAP commands
  - EXEC SQL … ENDEXEC.
- Used when database-specific commands have to be executed that are not part of Open SQL
- Native SQL is always hard-coded
  - Input is passed to placeholders (as in prepared statements)
- Native SQL bypasses SAP security features of Open SQL
  - Client separation
  - Restrictive access to SQL commands
- Native SQL can't access certain SAP tables
  - Cluster Tables and Pool Tables don't physically exists in the DB

- *No SQL Injection possible*, but should not be used anyway

Native SQL Example

Command EXEC SQL

```
REPORT  SQL_04.

DATA: f1 TYPE s_class.
DATA: f2 TYPE s_passname.
DATA: f3 TYPE s_date.

PARAMETERS p_carrid TYPE string.

EXEC SQL.
  SELECT CLASS, PASSNAME, FLDATE INTO :F1, :F2, :F3 FROM SBOOK
         WHERE CARRID = :p_carrid AND RESERVED = ' '
ENDEXEC.

WRITE: / f1, f2, f3.
```

NO SQL INJECTION

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5. ABAP Database Connectivity (ADBC)

ADBC Overview

- ADBC allows to dynamically execute *arbitrary* SQL commands
- ADBC is technically based on SAP kernel calls

  `CALL 'C_DB_EXECUTE'` …

  `CALL 'C_DB_FUNCTION'` …
- ADBC is provided in ABAP classes CL_SQL_* and a function module

  `CL_SQL_STATEMENT`

  `CL_SQL_PREPARED_STATEMENT`

  `DB_EXECUTE_SQL` (Function Module)
- ADBC bypasses SAP security features provided by Open SQL
  - Client separation
  - Restrictive access to SQL commands
  - Precompiled SQL statements
- Like Native SQL, ADBC can't access certain SAP tables

ADBC via CALL 'C_DB_EXECUTE'

```
REPORT  SQL_05.

DATA: lv_len    TYPE i.
DATA: lv_sqlerr TYPE i.

PARAMETERS lv_stmt TYPE c LENGTH 80.

lv_len = STRLEN( lv_stmt ).
CALL 'C_DB_EXECUTE' ID 'STATLEN' FIELD lv_len
                    ID 'STATTXT' FIELD lv_stmt
                    ID 'SQLERR'  FIELD lv_sqlerr.
```

ADBC INJECTION

- Executes an *arbitrary* SQL command (except SELECT)
- Used in function module DB_EXECUTE_SQL

ADBC via CALL 'C_DB_FUNCTION'

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```
REPORT  SQL_06.

PARAMETERS lv_stmt TYPE c LENGTH 80.

CALL 'C_DB_FUNCTION' ID 'FUNCTION' FIELD 'DB_SQL'
                     ID 'FCODE'    FIELD 'PO'
                     ID 'STMT_STR' FIELD lv_stmt
                     ...
```

ADBC INJECTION

- Executes an *arbitrary* SQL command
- Used in class CL_SQL_STATEMENT

ADBC Injection Demos

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DEMO

Related SAP Security Note

- SAP Note 1456569 – "Potential modification of persisted data" (https://service.sap.com/sap/support/notes/1456569)
- Virtual Forge Security Advisory SAP-NSI-01

Summary

- Despite common belief, OSQL Injections are possible in ABAP
- Despite common belief, arbitrary SQL statements can be executed on SAP systems, using ADBC
- The criticality of an OSQL Injection depends on the affected table and whether it is read or write access.
- A single *ADBC Injection* means complete compromise of the SAP system

SAP / ABAP Security Information

Organizations

BIZEC – Business Security Initiative
http://www.bizec.org

Literature

SAP PRESS

Sichere ABAP™-Programmierung

- Sicherheitslücken in ABAP-Programmen finden und schließen
- Lösungen für Bedrohungen wie Hintertüren, SQL-Injection, Cross-Site Scripting, Forceful Browsing, Phishing u.v.m.
- Inkl. Checklisten und Prüfmethoden für klassische ABAP-Anwendungen, Business Server Pages und Web Dynpro ABAP

Wiegenstein · Schumacher
Schinzel · Weidemann

Galileo Press

"Secure ABAP-Programming"
(Learn German first ;-)
SAP Press 2009

If you find new zero days

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Questions?

For the most current version of this document, visit
http://www.VIRTUALFORGE.com/

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